Claims

1. A solid-state imaging device comprising:

a plurality of light-receiving units two-dimensionally arrayed in a semiconductor substrate;

a filter unit operable to transmit incident light of selected wavelengths to the plurality of light receiving units; and

a light shielding unit operable to shield incident light, the light shielding unit having a plurality of apertures, each aperture opposing a corresponding light receiving unit, wherein

on a path of incident light from the light shielding unit to the plurality of light shielding units, the filter unit is disposed between the light shielding unit and the plurality of light-receiving units.

2. The solid-state imaging device of Claim 1, further comprsing

a condensing unit operable to condense incident light on the corresponding light-receiving unit disposed in each of the plurality of apertures in the shielding unit.

3. The solid-state imaging device of Claim 2, wherein the filter unit is composed of an inorganic material.

4. The solid-state imaging device of Claim 2, wherein the filter unit has a multilayer film structure.

5. The solid-state imaging device of Claim 2, wherein the filter unit is composed of photonic crystal.

6. A solid-state imaging device comprising:

a plurality of light-receiving units two-dimensionally arrayed in a semiconductor substrate; and

a filter unit operable to transmit light of selected wavelengths to the plurality of light receiving units, wherein

the filter unit is composed of photonic crystal.

7. A camera comprising a solid-state imaging device including:

a plurality of light-receiving units two-dimensionally arrayed in a semiconductor substrate;

a filter unit operable to transmit incident light of selected wavelengths to the plurality of light receiving units; and

a light shielding unit operable to shield incident light, the light shielding unit having a plurality of apertures, each aperture opposing a corresponding light receiving unit, wherein

on a path of incident light from the light shielding unit to the plurality of light shielding units, the filter unit is disposed between the light shielding unit and the plurality of light-receiving units.

8. A camera comprising a solid-state imaging device including:

a plurality of light-receiving units two-dimensionally arrayed in a semiconductor substrate; and

a filter unit operable to transmit light of selected wavelengths to the plurality of light receiving units, wherein

the filter unit is composed of photonic crystal.

9. A solid-state imaging device including a filter unit operable

to transmit incident light of selected wavelengths of order λ, wherein

the filter unit is a dielectric multilayer film that includes two λ/4 multilayer films, and an insulation layer sandwiched between the λ/4 multilayer films, the insulation layer having a thickness other than λ/4.

10. The solid-state imaging device of Claim 9, wherein

the dielectric multilayer film includes:

the insulation layer having an optical thickness other than λ/4,

the two λ/4 multilayer films, each including

a first dielectric layer having an optical thickness of λ/4 and being made of a material having a different refractive index from a material of the insulation layer,

a second dielectric layer having an optical thickness of λ/4 and being made of a material having a refractive index equal to the refractive index of the material of the insulation layer,

the first dielectric layer being formed on a main surface of the insulation layer,

the second dielectric layer being formed on a main surface, of the first dielectric layer, that faces away from the insulation layer.

11. The solid-state imaging device of either of Claims 9 and 10, wherein

the optical thickness of the insulation layer is set such that the filter unit transmits light of the selected wavelengths of order λ.

12. The solid-state imaging device of Claim 9, wherein

in a portion of the dielectric multilayer film corresponding to a light receiving unit,

the insulation layer has one or more through holes or grooves which penetrate in a direction vertical to the main surface of the insulation layer and are filled with a same material as the material forming the first dielectric layer,

the filter unit transmits light of a wavelength determined according to a ratio between an area of the one or more through holes or grooves, and an area of the insulation layer excluding the one or more through holes or grooves, when the insulation layer is seen in plan view.

13. The solid-state imaging device of Claim 9, further including

a plurality of light-receiving units two-dimensionally arrayed in a semiconductor substrate, wherein

each portion of the insulation layer corresponding to a light-receiving unit has an inwardly inclined lateral surface.

14. The solid-state imaging device of Claim 9, further including

a plurality of light-receiving units two-dimensionally arrayed in a semiconductor substrate, wherein

a region of the insulation layer through which light incident on a corresponding light-receiving unit is to be transmitted has a plurality of sections, each having a different thickness.

15. The solid-state imaging device of Claim 9, wherein

an absorbing member for absorbing light reflected by the dielectric multilayer film is provided on the side of the dielectric multilayer film to which the light is reflected.

16. The solid-state imaging device of Claim 16, wherein the absorbing member is a color filter containing pigments or dyes.

17. A camera including the solid-state imaging device of Claim 9, the solid-state imaging device including the filter unit that is composed of a multilayer dielectric film and transmits incident light of selected wavelengths of order λ.

18. A manufacturing method of a solid-state imaging device including a filter unit that transmits incident light of selected wavelengths of order λ, the filter unit being formed by conducting the following steps:

a first formation step of forming a first dielectric multilayer film on a semiconductor substrate, the first dielectric multilayer film consisting of a plurality $\lambda/4$ optical films;

a second formation step of forming a first insulation layer on the first dielectric multilayer film;

a first removal step of removing the first insulation layer except for a first region;

a third formation step of forming a second insulation layer on the first dielectric multilayer film and the first region of the first insulation layer;

a second removal step of removing a second region of the second

insulation layer, the second region being positioned on the first dielectric multilayer film; and

a fourth formation step of forming a second dielectric multilayer film on the second insulation layer and the first dielectric multilayer film, the second dielectric multilayer film consisting of a plurality of $\lambda/4$ optical films.

19. A manufacturing method of a solid-state imaging device including a filter unit that transmits incident light of selected wavelengths of order λ, the filter unit being formed by conducting the following steps:

a first formation step of forming a first dielectric multilayer film on a semiconductor substrate, the first dielectric multilayer film consisting of a plurality $\lambda/4$ optical films;

a second formation step of forming a first insulation layer on a first region of the first dielectric multilayer film by using a liftoff method;

a third formation step of forming a second insulation layer on a second region of the first dielectric multilayer film by using the liftoff method, the second region being different from the first region; and

a fourth formation step of forming a second dielectric multilayer film on the first insulation layer, the second insulation layer, and the first dielectric multilayer film, the second dielectric multilayer film consisting of a plurality of $\lambda/4$ optical films.

20. A manufacturing method of a solid-state imaging device including a filter unit that transmits incident light of selected

wavelengths of order λ, the filter unit being formed by conducting the following steps:

a first formation step of forming a first multilayer dielectric film on a semiconductor substrate, the first multilayer dielectric film consisting of a plurality λ/4 optical films;

a second formation step of forming a first insulation layer on the first dielectric multilayer film;

a first removal step of removing the first insulation layer except for a first region;

a third formation step of forming a second insulation layer on the first insulation layer in a second region that is within the first region, and on a region of the first dielectric multilayer film where the first insulation layer is not formed, by using a liftoff method; and

a fourth formation step of forming a second dielectric multilayer film on the first insulation layer, the second insulation layer, the second dielectric multilayer film consisting of a plurality of λ/4 optical films.

21. A manufacturing method of a solid-state imaging device including a filter unit that transmits incident light of selected wavelengths of order λ, the filter unit being formed by conducting the following steps:

a first formation step of forming a first multilayer dielectric film on a semiconductor substrate, the first multilayer dielectric film consisting of a plurality λ/4 optical films;

a second formation step of forming a first insulation layer on the first dielectric multilayer film;

a first removal step of removing the first insulation layer except for a first region;

a third formation step of forming a second insulation layer on the first dielectric multilayer film and the first region of the first insulation layer, the second insulation layer being made of a different material from the first insulation layer;

a second removal step of removing the second insulation layer, except for a portion in a second region on the first insulation layer; and

a fourth formation step of forming a second dielectric multilayer film on the first insulation layer, the second insulation layer, and the first dielectric multilayer film, the second dielectric multilayer film consisting of a plurality of $\lambda/4$ optical films.

22. A manufacturing method of a solid-state imaging device including a plurality of light-receiving units two-dimensionally arrayed in a semiconductor substrate, and a filter unit that transmits incident light of selected wavelengths of order λ, the filter unit including two dielectric multilayer films, each consisting of a plurality of $\lambda/4$ optical films, and an insulation layer sandwiched between the two dielectric multilayer films, the manufacturing method comprising:

a formation step of forming a resist in a middle of each of a plurality of insulation layer portions that oppose the plurality of light receiving units; and

a shaping step of shaping the insulation layer portions by etching, to give each insulation layer portion at least one inclined lateral surface.

23. The manufacturing method of Claim 22, wherein

in the formation step, the resist is formed so as to have an inclined lateral surface.

24. The manufacturing method of Claim 23, wherein

in the formation step, the resist is formed so as to have an inclined lateral surface, by varying an amount of exposure to light.

25. The solid-state imaging device of Claim 9, further including:

a plurality of light-receiving units two-dimensionally arrayed in a semiconductor substrate;

the filter unit transmitting light of differing wavelengths according to a corresponding light receiving unit, wherein

(i) Lack or presence of the insulation layer, (ii) one of the thickness and material of the insulation layer, or (iii) a combination of thickness and material of the insulation layer differ depending on the wavelength of light to be transmitted to the opposing light receiving unit.

26. The solid-state imaging device of Claim 9, further including:

a plurality of light-receiving units two-dimensionally arrayed in a semiconductor substrate; and

the filter unit transmitting light of differing wavelengths according to a corresponding light receiving unit, wherein

the two $\lambda/4$ multilayer films are symmetrically structured with

respect to the insulation layer.

27. A solid-state imaging device including a filter unit that transmits incident light of selected wavelengths of order λ, wherein

the filter unit is a dielectric multilayer film that includes two types of dielectric layer, each type having a different refractive index,

in the dielectric multilayer film, a dielectric layer furthest from the light-receiving unit has a lower of the two refractive indices.

28. A solid-state imaging device including a filter unit that transmits incident light of selected wavelengths of order λ, wherein

a protective layer is provided on one of main surfaces of a dielectric multilayer film, or between any given pair of dielectric layers making up the dielectric multilayer film.

29. The solid-state imaging device of Claim 28, wherein the protective layer is composed of silicon nitride.

30. The solid-state imaging device of Claim 9, further including:

a plurality of light-receiving units two-dimensionally arrayed in a semiconductor substrate;

a plurality of light-condensing units each operable to condense incident light;

the filter unit having a plurality of portions, each portion transmitting light of a particular wavelength that depends on a corresponding light receiving unit, wherein

a filter unit main surface that faces away from the plurality of light-receiving units is flat.

31. A solid-state imaging device comprising:

a plurality of light-receiving units two-dimensionally arrayed in a semiconductor substrate; and

a filter unit that transmits incident light of wavelengths of order λ, wherein

the filter unit includes a dielectric multilayer film including dielectric layers of two types, each type having a different refractive index,

a distance between (i) the plurality of light-receiving units and (ii) a higher refractive index layer that is positioned closest, among the higher refractive index layers in the dielectric multilayer film, to the plurality of light-receiving units falls within a range of 1 nm and λ inclusive.

32. A solid-state imaging device including a filter that transmits light of selected wavelengths of order λ, and a two-dimensional array of unit pixels, each unit pixel comprising:

a light-receiving unit operable to detect an intensity of light; and

a filter unit portion composed of a multilayer dielectric film that transmits one of red light, green light, and blue light, wherein

the plurality of unit pixels are arranged in Bayer array according to a color of light transmitted by the filter unit portion, in such a manner that every square area including four adjacent unit pixels has two unit pixels that each include the filter portion that

transmits blue light.